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This talk is a brief summary of
"Probing the exchanged objects(s) in
diffractive scattering" by

C. Boros, Z. Liang and T. Meng

[hep-ph/9610380]

$$\gamma^* p \rightarrow V p \quad (e^- p \rightarrow e^- V p)$$

$$V = g, \omega, \phi, J/\psi$$

$$\gamma^* p \rightarrow \Xi p \quad (e^- p \rightarrow e^- \Xi p)$$

$$p p \rightarrow (\Lambda K^+) p$$

$$p A \rightarrow (\Lambda K^+) A$$

A: nucleus

X Talk given by T. Meng (FU-Berlin)
at DIS 97 in Chicago

Experiments at HERA in the small- x_B region

H1- and ZEUS - Data show

- gluon-dominance } in this ($x_B < 10^{-2}$, say)
- existence of LRG event } kinematical region

- Are these phenomena related to each other?
- Are LRG events due to the interacting soft gluons
in particular:

colorless objects = color singlet gluon clusters

These questions have been discussed in a recent paper

C. Boros, Z. Liang and T. Meng PRD 54 6658 (1996),

in which we have shown that

they should be answered in the affirmative.

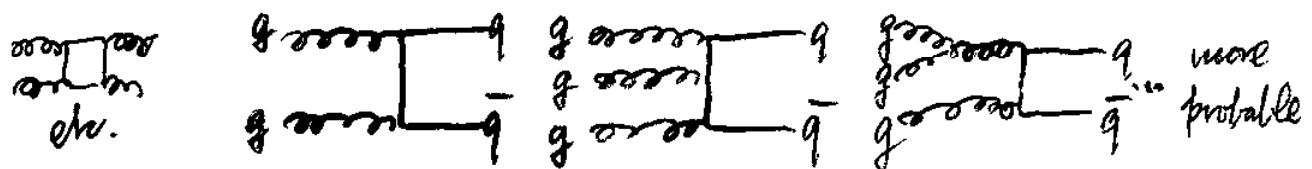
The question whether Pomeron is related to gluon
has been discussed many years ago by

F. Loi PR D 12 183 (1975)

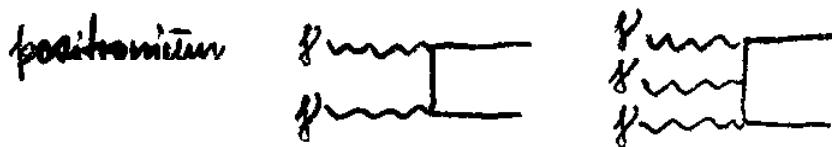
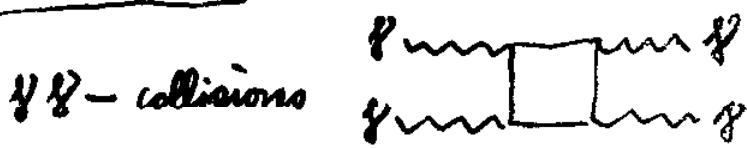
S. Nussinov, PRL 34 786 (1975), PRD 14 246 (1976)

Detecting soft gluons / soft gluon-systems

Kinematical considerations:

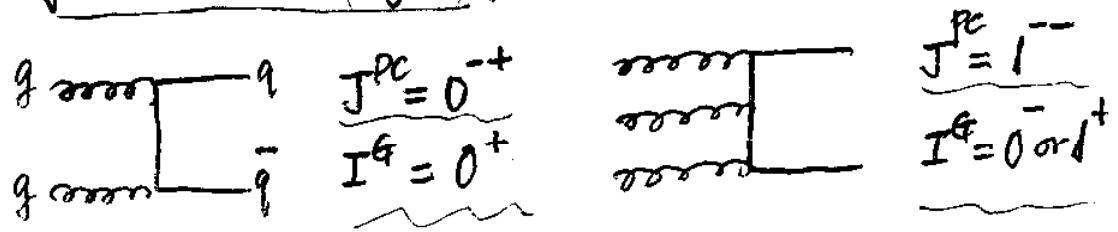


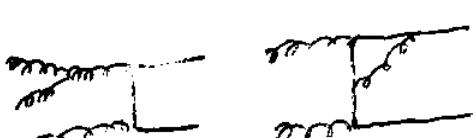
QED analog:



$$P_c \text{ conservation} \Rightarrow \underline{J^{PC} = 0^{-+}}, \quad \underline{J^{PC} = 1^{--}}$$

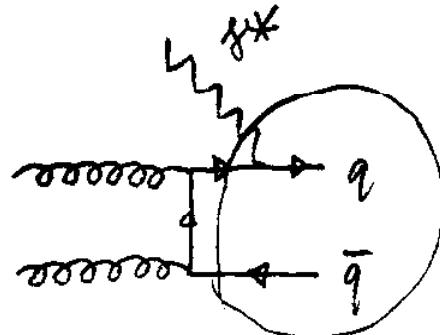
gluon clusters (C_0^{*}/\circ):



note:  etc. also possible

Q^2 small

$$\left\{ \begin{array}{l} |\vec{q}| \text{ small } (\because Q^2 = -q^2 = |\vec{q}|^2 - q_0^2 = q_0^2 + |\vec{q}_\perp|^2 - q_0^2) \\ \text{tr. dim of } g^* \text{ large } (\because |\vec{x}_\perp| \propto 1/|\vec{q}_\perp|) \end{array} \right.$$



(Recall: qu. & of $q\bar{q}$)

$$J^{PC} = 0^{-+}, I^{G-} = 0^{++}$$

$$J^{PC} = 1^{--}$$

Quantum # of the $(g^* q\bar{q})$ system:

(Recall: em. int. P, C, T, K)

$$I^G = 0^- \text{ or } 1^+$$

Hence, we expect to see
vector meson ($\rho, \omega, \phi, J/\psi$) production in

$$g^* p \rightarrow V p \quad (e^- p \rightarrow e^- V p)$$

The expected W^2 - and Q^2 -dependence are:

production rate

↓ for ↑ Q^2 (\because easier to break up)

↑ for ↑ W^2
(fixed Q^2)

$$\begin{cases} \therefore W^2 = Q^2 \left(\frac{1}{x_B} - 1 \right) + M^2 \\ \text{and gluon-densit.} \\ \uparrow \text{for } \downarrow x_0 \end{cases}$$

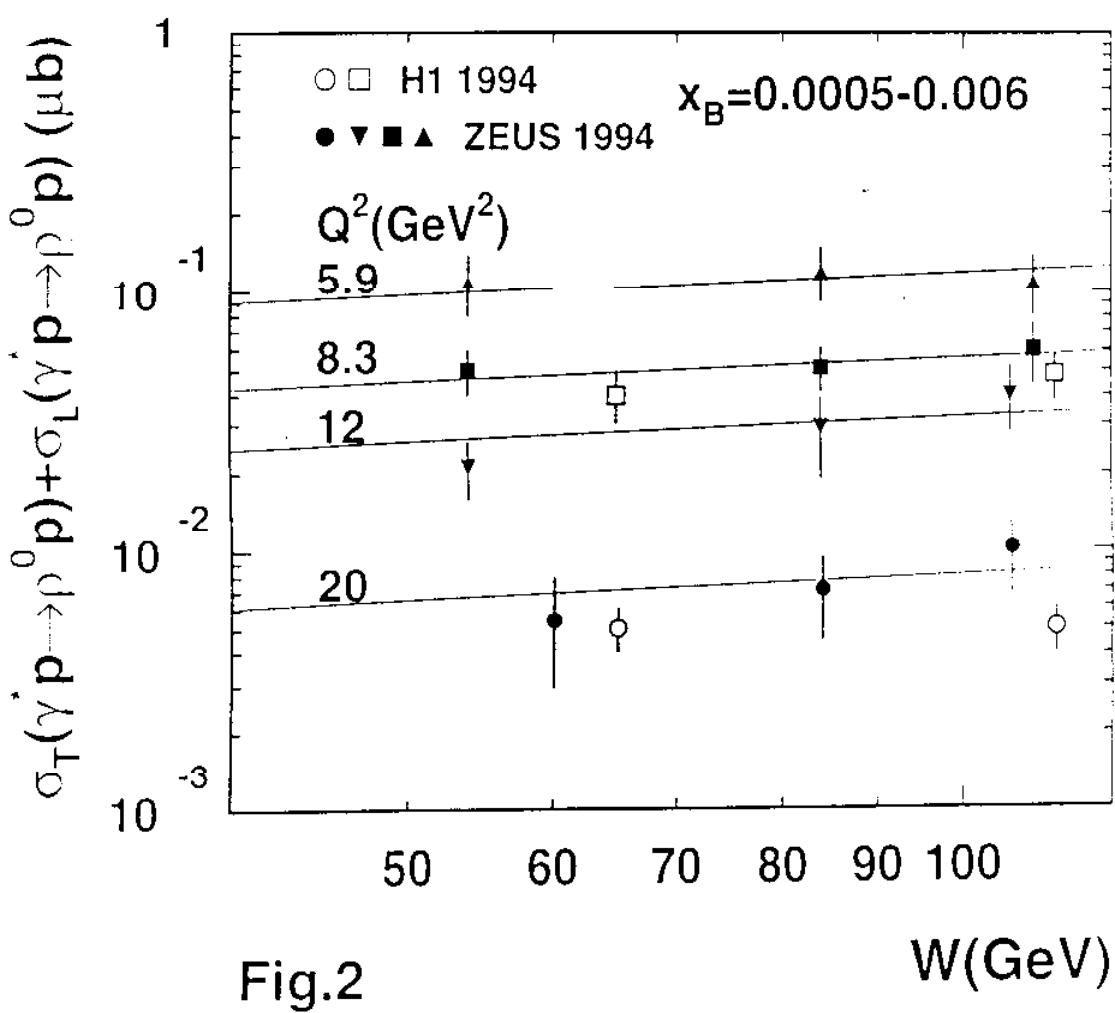
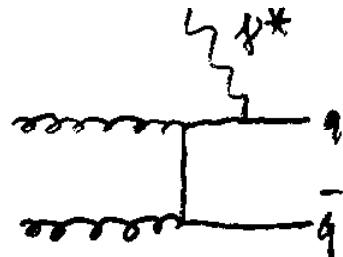


Fig.2

Q^2 large

$\{ |q|$ large

{ tr. dim. of f^* small (more point-like)



either q or \bar{q} of the $(q\bar{q})$ -system will be knocked out

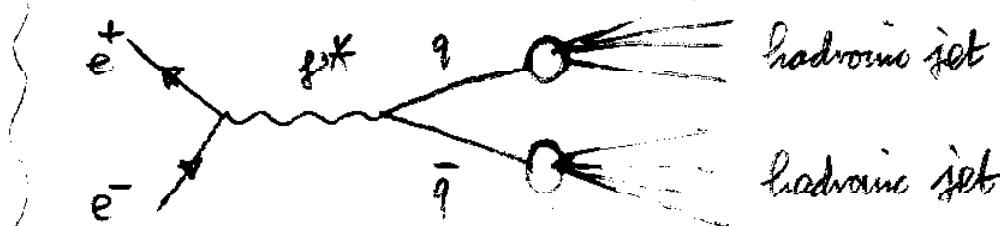
(recall: $J^{PC} = 0^{-+}, I^G = 0^+$)

$q\bar{q} \star$ of the $f^* q\bar{q}$ system

either $(f^* q) \oplus \bar{q}$ or $q \oplus (f^* \bar{q})$

$\Rightarrow J^{PC} = 1^{--}, I^G = 0^-$ or 1^+

{ same as in $e^- e^+ \rightarrow f^* \rightarrow q\bar{q}$



distribution of the produced hadrons are expected
to be symmetric with respect to
 $f^*(q\bar{q})$ center-of-mass

Hence we see TETSET to determine a model distribution

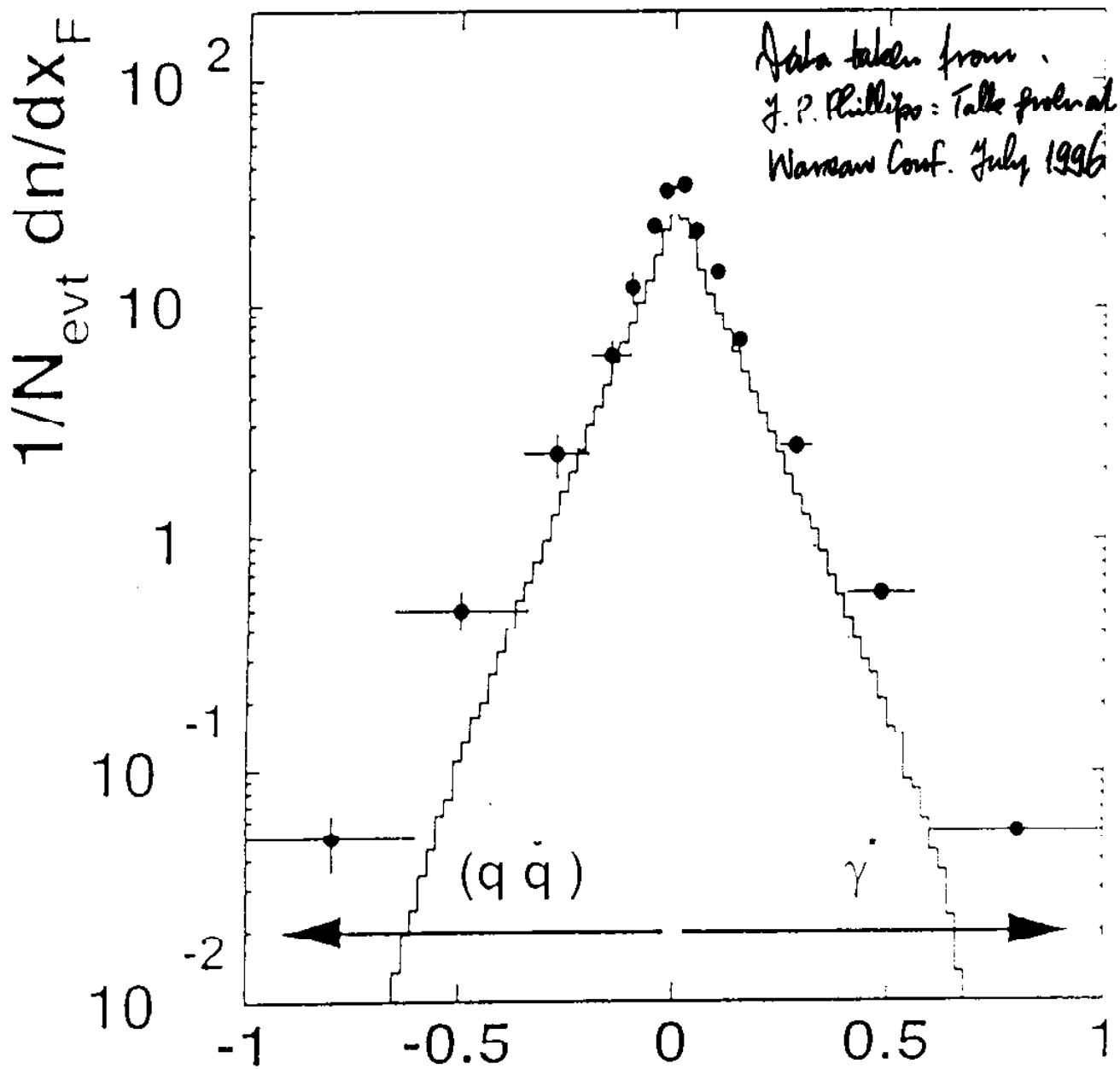


Fig.3(a)

$$\chi_F \equiv \frac{z p_i^*}{M_x}$$

p_{11}^* is the longitudinal momentum of the observed hadron
in the $\chi^*(q\bar{q})$ cms. frame
(the $\chi^*, p \dots \dots$)

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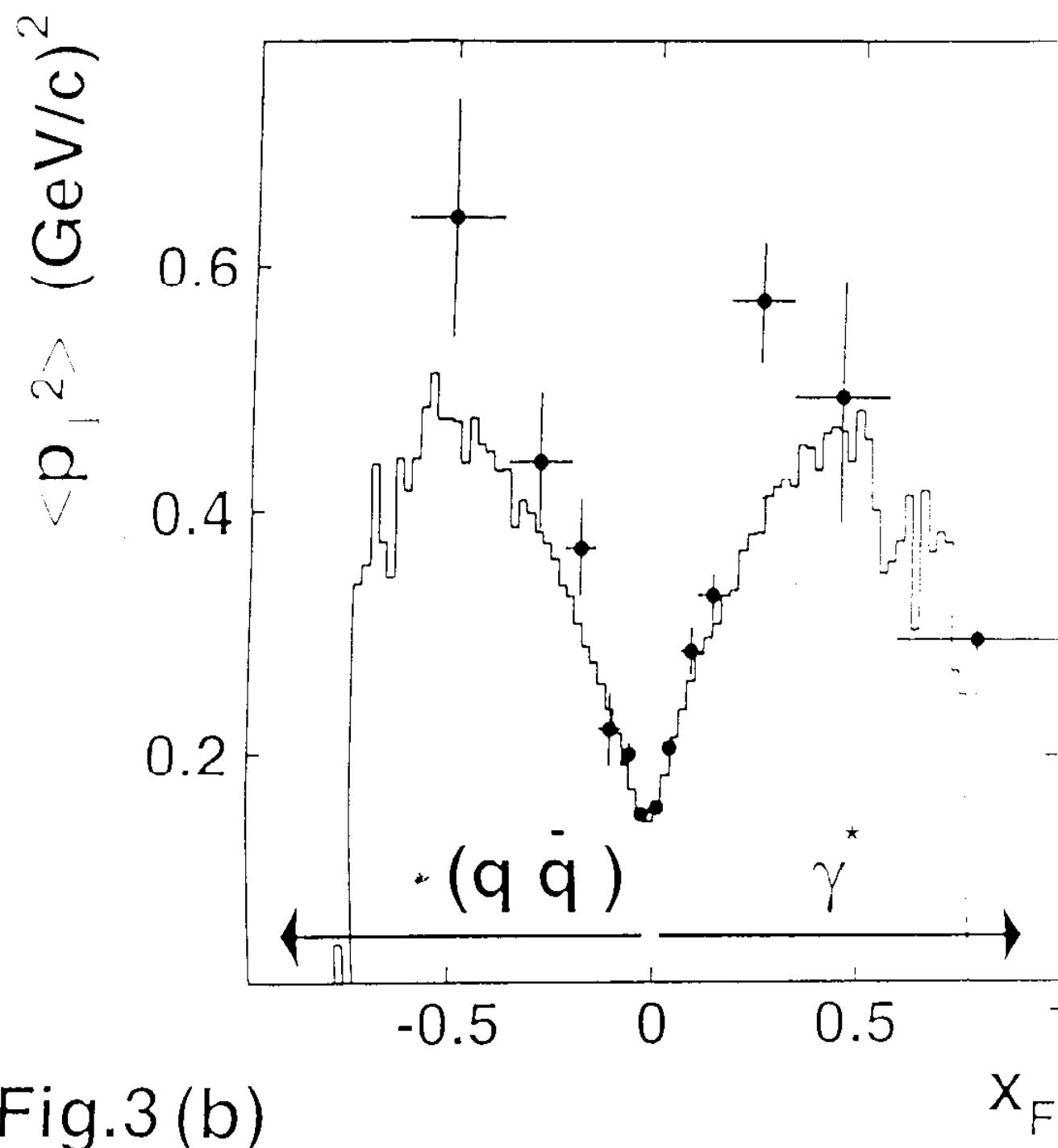


Fig.3 (b)

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What happens when we increase Q^2
by keeping x_B and x_p fixed?

Answer:

qualitative: the proposed picture \Rightarrow

hadron distributions should be
more jet-like

quantitative: since $M_x^2 \approx Q^2 \left(\frac{x_p}{x_B} - 1 \right)$ implies

$M_x^2 \uparrow$ for $\uparrow Q^2$

we look at experiments at $\uparrow M_x^2$

use JETSET to do the calculation

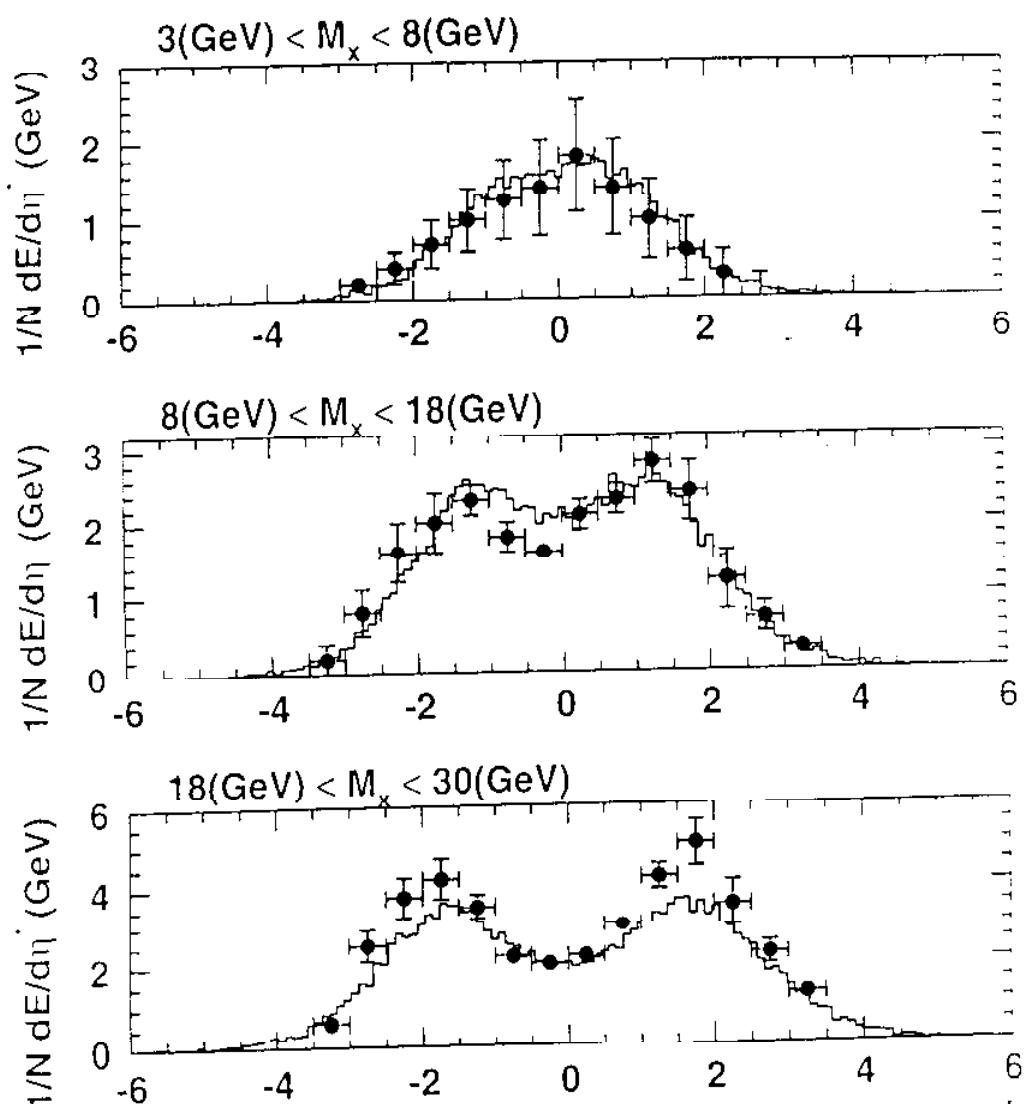


Fig.4

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High-energy single-diffractive
hadron-hadron and hadron-nucleus scattering



are of particular interest, because P_Λ , the transverse polarization of Λ has been observed not only in inclusive processes

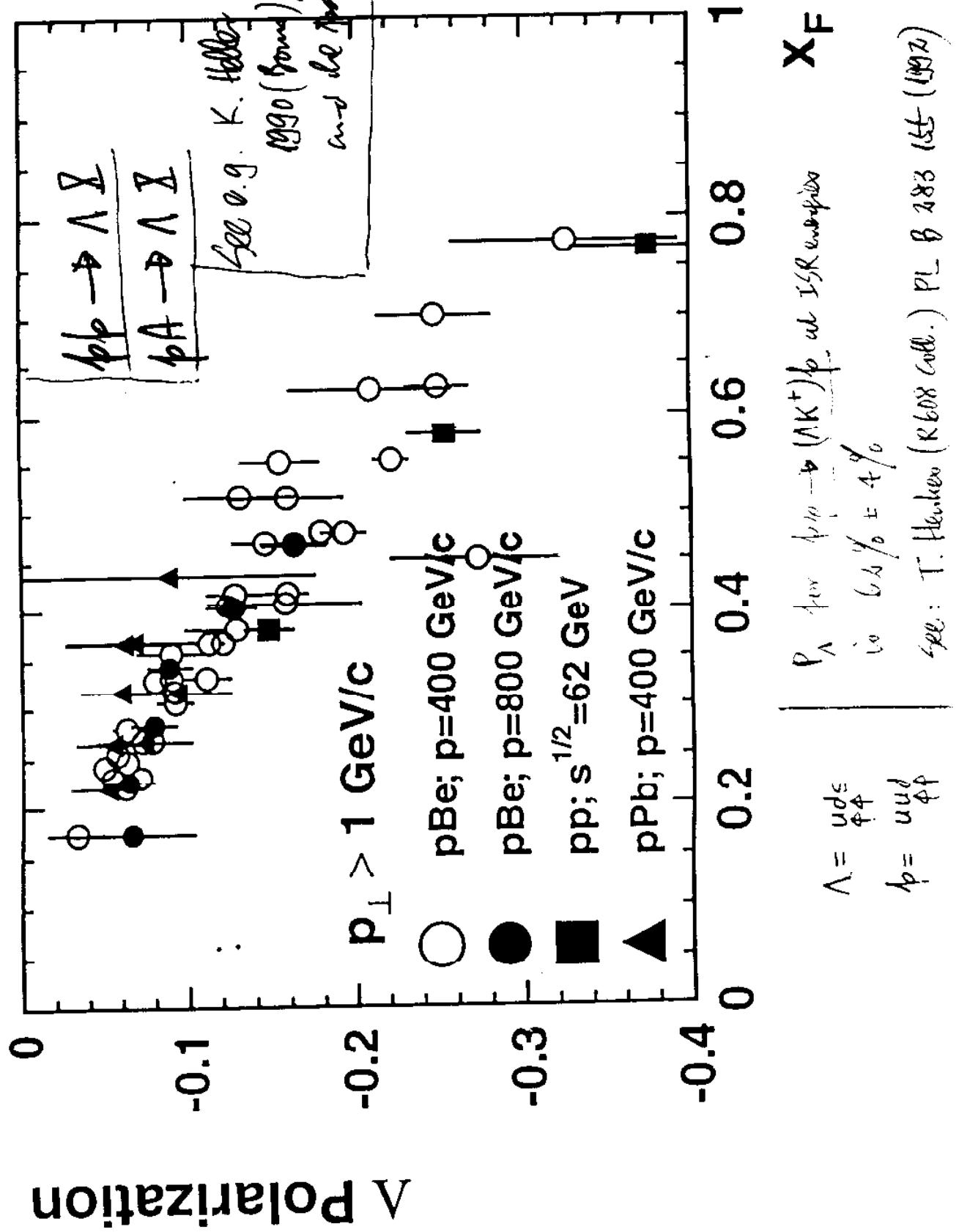


but also in the above-mentioned diffractive processes
although

{ neither the projectile
nor the target
is polarized.

The observed polarization P_Λ in diffractive processes
is much higher than that in inclusive reactions

Why?



We recall that the striking features observed in single-spin hadron-hadron collisions e.g.

$$p(\uparrow) + p \rightarrow \pi + X, \quad (\pi = \pi^0, \pi^+, \pi^-)$$

$$\bar{p}(\uparrow) + p \rightarrow \pi + X,$$

especially the flavor-dependence and the project-dependence of the observed left-right asymmetry A_N can be understood in terms of a relativistic quark model:

Keypoints of the proposed picture

for details, see:

C. Bors, Z. Liang and T. Meng
PRL 70 1751 (1993) and
PRD 51 4867 (1995)

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I. Part of the mesons observed in the projectile fragmentations region

($x_F \geq 0.4$) are directly formed by the valence quarks of the projectile
— also when the projectile hadron is polarized.

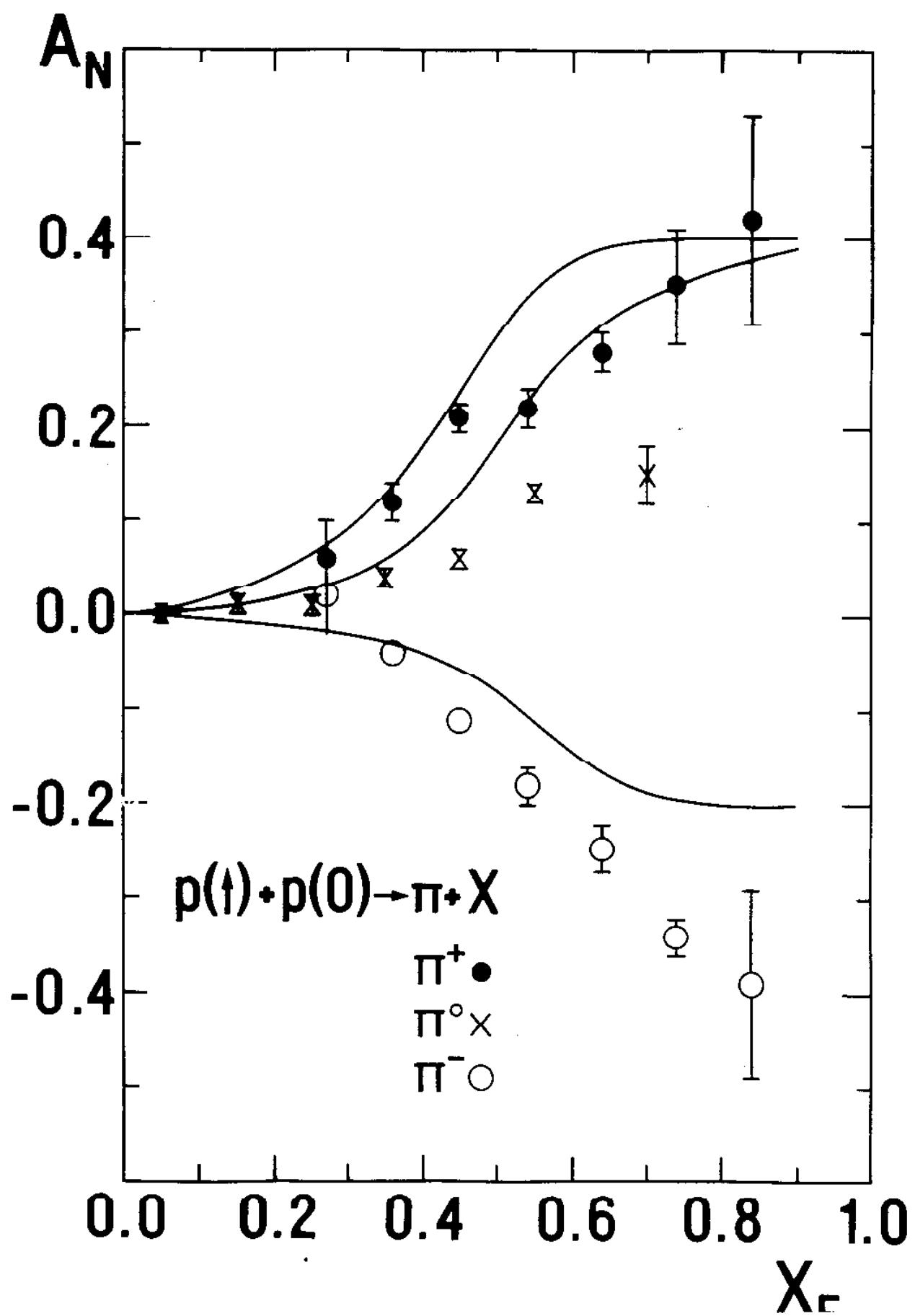
II. Every valence quark in the hadron can be considered as a Dirac particle

in an effective confining potential (due to the other constituents of the hadron). Hence, the groundstate of a given quark with a given color and a given flavor can be characterized by its energy, its total angular momentum ($j = 1/2$, $j_z = -1/2$ or $+1/2$) and its parity ($P = -1$).

III. In the framework of the proposed relativistic quark model, wave functions for the baryons can be obtained simply by replacing the Pauli 2-

spinors in the static quark model by the corresponding Dirac 4-spinors which describe the groundstates of the valence quark.

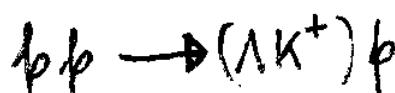
IV. Taken together with the fact that hadrons are spatially extended objects and that color forces are confined inside the hadrons, causality requires the existence of a "surface effect" in such production processes.



The validity of the relativistic quark model implies
 the existence of a close relationship between
 the polarization of the valence quarks of the
 transversely polarized projectile
 [here $p(\uparrow)$ or $\bar{p}(\downarrow)$]
 and
 the directly formed mesons [here π^{\prime} 's or K^{\prime} 's]
 in the projectile - fragmentation region

In other words, in this picture,
 knowing the probability of observing a meson on
one side (left or right) of the collision axis,
the chance for the valence quarks of the projectile
to be polarized in a given direction perpendicular
to scattering plane is determined.

Having this picture in mind, we see that
 the JPC of the $s\bar{s}$ pair plays a decisive role
 in the process



$$\vec{n} = \frac{\vec{p}_B \times \vec{p}_\Lambda}{|\vec{p}_B \times \vec{p}_\Lambda|}$$

The diagram illustrates the decomposition of the unit vector \vec{n} into components along the momentum vectors \vec{p}_B and \vec{p}_Λ . A rightward arrow labeled "right" indicates the direction of \vec{p}_B , and a leftward arrow labeled "left" indicates the direction of \vec{p}_Λ . The vector \vec{p}_Λ is also associated with the baryon $\Lambda(\downarrow) = (ud)_v(0)s_s(\downarrow)$. Below the horizontal axis, a vector \vec{p}_K is shown, associated with the kaon $K^+(0) = u_v(\downarrow)\bar{s}_s(\uparrow)$.

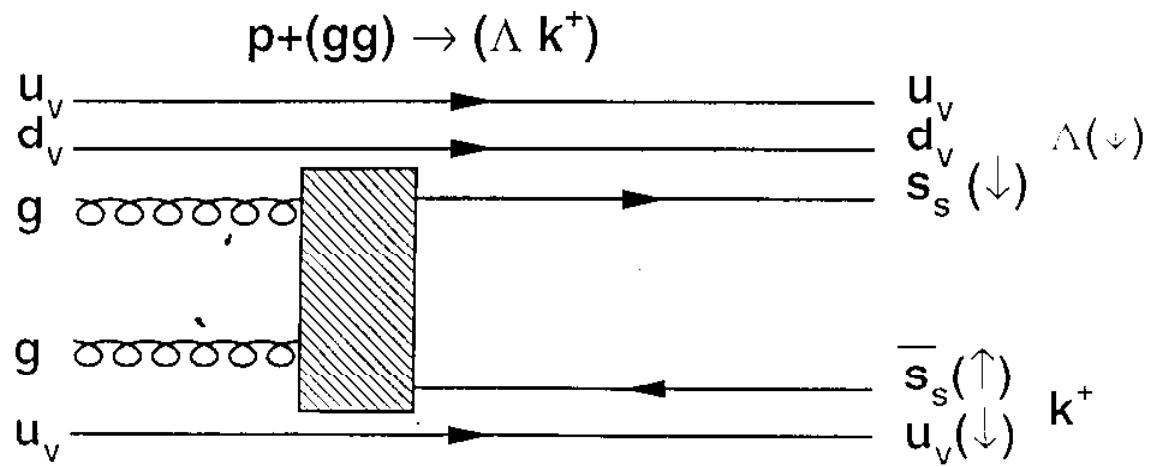


Fig.5

A considerable part of
"the exchanged colorless objects"

in diffractive scattering processes,
in particular those in

- $\gamma^* p \rightarrow V p \quad (\bar{e} p \rightarrow \bar{e} V p)$

$$V = g, \omega, \phi, J/\psi$$

- $\gamma^* p \rightarrow \Xi p \quad (\bar{e} p \rightarrow \bar{e} \Xi p)$

- $p p \rightarrow (\Lambda K^+) p$

- $p A \rightarrow (\Lambda K^+) p$

? have the following quantum numbers

$$\begin{cases} J^{PC} = 0^{-+} \\ I^G = 0^+ \end{cases}$$

> (not those of Pomerons!)

the "new scalar (0-) gauge boson" needed to explain
the $D\bar{D}$ data?